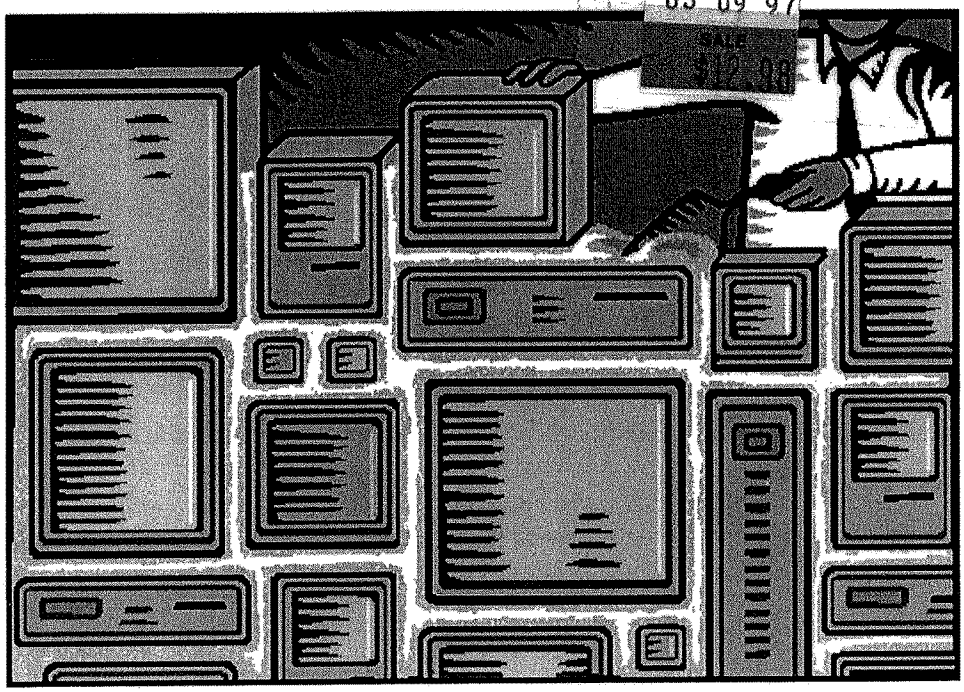
EXHIBIT 1

THE NETWORK TROUBLESHOOTING LIBRARY

INTERNETWORKING

A Guide to Network Communications

LAN to LAN; LAN to WAN



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1.4 Applying Connectivity Devices to the OSI Model

Let's explore how connectivity devices work with regard to OSI protocols. We'll return to the peer protocol model (Figure 1-2) and assume that the two open systems are connected with a physical transmission medium such as a twisted pair or fiber optic cable. What happens if the cable length is so long that the signal loses power? We can solve this by adding a repeater (see Figure 1-6) that will amplify (or regenerate) the physical signal. Repeaters function at the Physical Layer and operate between like networks, such as Token Ring to Token Ring, or Ethernet to Ethernet. A repeater can be added to the internetwork to extend the range of the network; connected segments behave physically (and logically) as a single network.

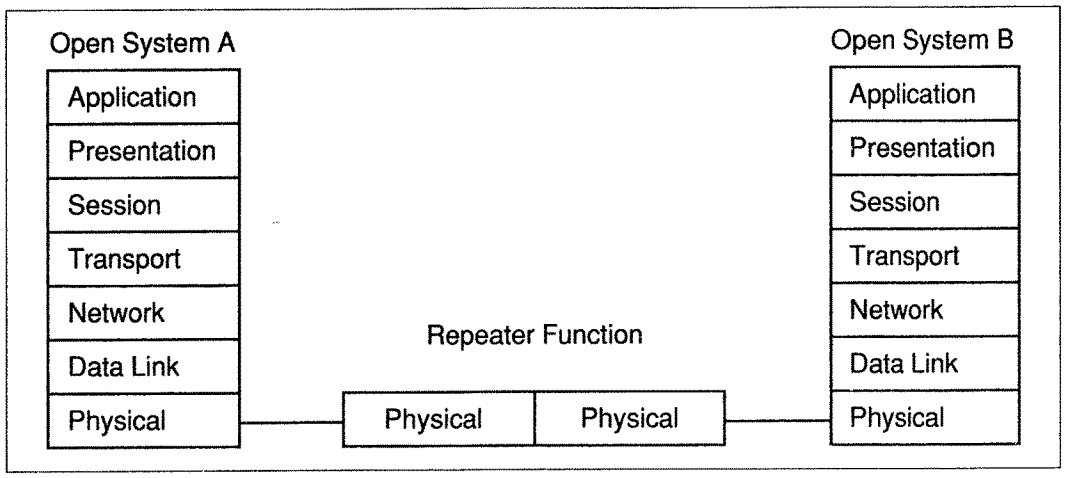

Figure 1-6. Comparing a Repeater to OSI

When repeating a signal is insufficient for the existing network, a bridge adds the functionality of the Data Link Layer (Figure 1-7). The bridge logically separates two network segments by operating upon the address within the Data Link Layer (or IEEE Medium Access Control [MAC]) frame. Information that is either stored at the bridge or provided within the transmitted frame assists the bridge in making a rather simple decision: pass the frame to the next segment (known as forwarding) or do not pass the frame to the next segment (known as filtering). Bridges operate on networks having compatible Data Link Layer addressing schemes (such as IEEE 802.3 to

802.3, or 802.3 to 802.5), but are transparent to the protocols of the Network and higher layers.

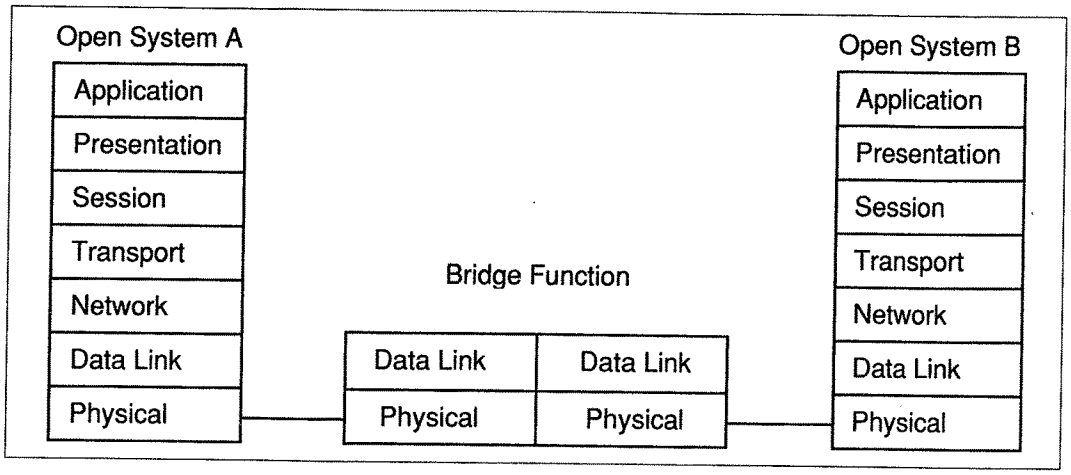

Figure 1-7. Comparing a Bridge to OSI

Routers operate at the Network Layer (see Figure 1-8), and may interpret either one or more protocols at that layer. Recall that the Network Layer makes a choice between available paths within the communication subnet, eventually connecting the source and destination hosts. A router performs similarly, reading information about the destination network address, and forwarding that packet to the appropriate destination network. (Bridges, as discussed above, make a simple binary decision to forward or not forward a frame after examining the Data Link Layer address). The router thus serves a network-wide connectivity function. Routers may operate on one Network Layer protocol, such as the DoD Internet Protocol (IP), or multiple protocols such as IP, DECnet, and Novell's IPX (Internetwork Packet Exchange).

Finally, gateways may operate at all seven OSI layers (see Figure 1-9). Gateways are application-oriented, and may be responsible for connecting incompatible electronic mail systems, converting and transferring files from one system to another, or enabling interoperability between dissimilar operating systems. Chapter 9 will be devoted to various application-specific gateways.

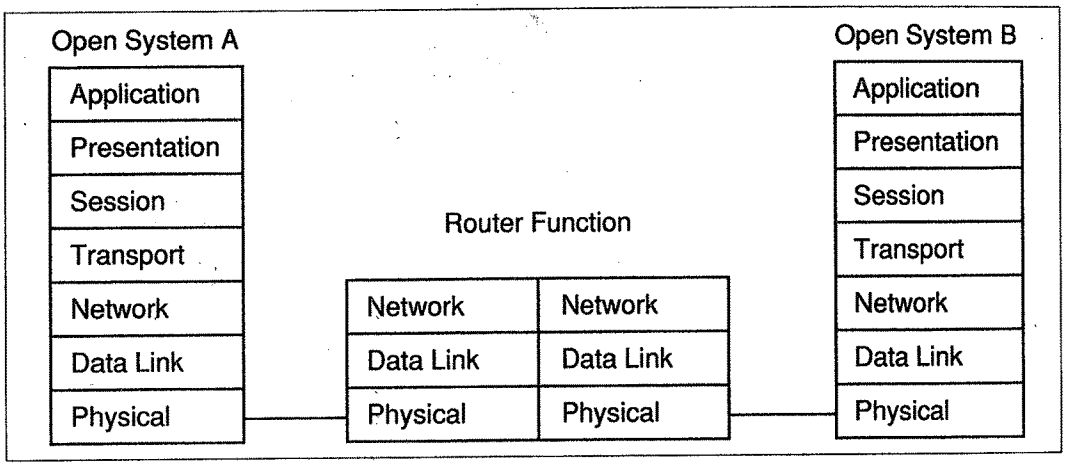

Figure 1-8. Comparing a Router to OSI

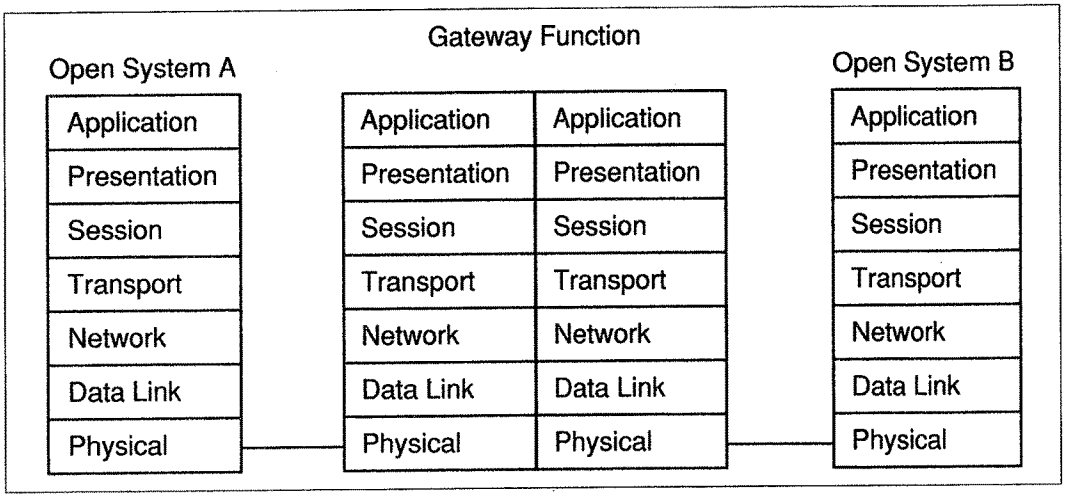

Figure 1-9. Comparing a Gateway to OSI

A great deal of literature is available on the subject of LAN connectivity devices. Reference [1-20] is a good overview of the technologies, and discusses device operation in depth. Reference [1-21] looks at the connectivity design issues from an OSI perspective. Bridges and their applications are discussed in reference [1-22]; router architecture is explored in references [1-23] and [1-24]; gateways are profiled in [1-25].